REMARKS

In view of the foregoing amendments and following remarks responsive to the second Office Action dated November 6, 2002, Applicant respectfully requests favorable reconsideration of this application.

The Patent and Trademark Office (Office) has rejected all pending claims, claims 1-20 and 24-29, under 35 U.S.C. §102(e) as anticipated by Abbott.

The Present Invention

The present invention relates generally to flip chip bonding of semiconductors. More particularly, the invention introduces a new type of solder ball for use in flip chip type bonding. The solder ball comprises a substantially non-deformable dielectric core, a solderable metal layer over the core, and a solder layer over the metal layer. The dielectric core has a higher melting temperature than the solderable metal layer.

During the process of interconnecting two substrates in accordance with the present invention, the solder balls are placed on a pick up tool, such as a vacuum pick up tool, and are dipped in flux. The pick up tool is then positioned over the first substrate and lowered to place the solder balls in contact with the solder pads of the first substrate. The pick up tool is removed, leaving the solder balls on the solder pads. The first substrate is then heated to reflow the solder on the solder ball so that the solder balls become affixed to the solder pads of the first substrate. The second substrate is then positioned over the first substrate and lowered so as to bring the

solder pads of the second substrate in contact with the solder balls. The entire assembly is then heated again to reflow the solder on the solder balls causing the two substrates to become mechanically and electrically connected through the solder balls.

The Abbott Reference

Abbott discloses a composite connection structure for semiconductor interconnections and a related method of interconnecting integrated circuits or packages using the structure. The structure is a solder ball comprising a core element formed of a metal, ceramic or polymer coated with two solder-compatible metal layers. The need/purpose of having two metal layers on the core element is essentially irrelevant to the present invention and, therefore, is not discussed herein. What is extremely relevant to the present case is that Abbott's solder ball is not coated with solder. Rather, during the process of interconnecting integrated circuits and/or packages, solder is deposited on the bond pads of the two circuit elements that are to be electrically connected by the solder balls. More particularly, in Abbott, solder paste is applied to the bond pads of the circuit elements. Then the solder balls (which have no solder) are laid on top of the bond pads of one of the circuit elements and the solder is reflowed to affix the solder balls to the solder pads of the first circuit element. Then the second circuit element (also bearing solder on its solder pads) is brought into contact with the solder balls. Then, the solder on the second circuit element is reflowed to electrically and mechanically bond the two circuit elements to each other via the solder balls and solder.

Applicant's Response to the Rejections

Applicant has herein amended the independent claims to more clearly distinguish over Abbott. Particularly, the claims have been amended to make clear that the solder balls include the solder as a layer over the solderable metal layer. Abbott's solder ball does not include solder, only a core and two metal layers. In Abbott, the solder is applied to the solder pads on the circuit elements, whereas, in the present invention, the solder is the outer layer of the inventive solder ball itself. As stated in the specification, one of the key advantages of the present invention is a reduction in the number of processing steps to interconnect two substrates. Specifically, the entire interconnection is provided in the solder ball itself and it merely needs to be placed on the first substrate and heated and then placed in contact with the second substrate and heated. Abbott still requires the separate, additional steps involved in depositing the solder on the bond pads of the two circuit elements. The present invention eliminates these steps by providing a single pre-manufactured article that includes the core, the solderable metal layer and the solder.

Applicant has amended the independent claims to more distinctly recite these distinctions over Abbott. Claims 1 and 24 are drawn to the article itself and, prior to amendment, already clearly distinguished over Abbott since Abbott's solder ball does not include solder. Nevertheless, to even more clearly distinguish over Abbott, claims 1 and 24 now recite that the solder is a layer completely surrounding the underlying metal layer. As can be seen in Abbott's Figures 6A, 6B, 7, 8, and 11A, the solder ball itself (prior to being used to interconnect two circuit elements) has no solder at all. Further, even after being used to interconnect two circuit elements, at no time is the

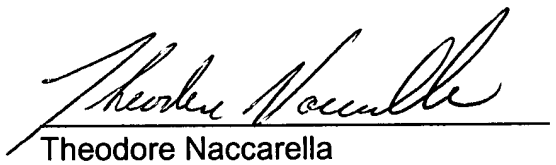
solder ball completely covered with solder. Therefore, these claims clearly distinguish over Abbot.

Independent claims 9, 16, 25, and 26 recite essentially the same basic invention as claims 1 and 24 in different contexts. Specifically, claims 9 and 25 recite a substrate bearing the inventive solder balls and claims 16 and 25 recite the completed interconnect comprising two substrates interconnected by the inventive solder ball. These claims have been amended in essentially the same manner as discussed above in relation to claims 1 and 24 and, therefore, also clearly distinguish over Abbott by virtue of the fact that, even after interconnection in Abbott, the solder does not completely surround the solder ball. Particularly, even though the combination (as opposed to the solder ball as a separate and distinct article) obviously includes solder, the solder does not completely surround the solder ball since the solder did not start out as a layer on the solder ball, but instead started out as deposits on the solder pads of the two substrates.

In view of the foregoing amendments and remarks, this application is now in condition for allowance. Applicant respectfully requests the Examiner to issue a Notice of Allowance at the earliest possible date. The Examiner is invited to contact

Applicant's undersigned counsel by telephone call in order to further the prosecution of this case in any way.

Respectfully submitted,



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Marked Up Version of the Claims

The claims have been amended as shown below.

1. (Twice Amended) A solder-coated article comprising:

a substantially non-deformable dielectric core having a largest dimension ranging from 1 to 1000 microns;

a solderable metal layer [over] completely surrounding said core; and

a solder layer [over] completely surrounding said metal layer.

9. (Twice Amended) A modified substrate comprising:

a substrate;

a metalized pad on said substrate; and

a bump feature on said metalized pad, said bump feature comprising a substantially non-deformable dielectric core; a solderable metal layer [over] completely surrounding said core; and a solder region [contacting at least a portion of] completely surrounding said solderable metal layer and contacting at least a portion of said metalized pad.

16. (Twice Amended) A solder bonded assembly comprising:

a first substrate comprising a first solder pad;

a second substrate comprising a second solder pad;

a bump feature comprising a substantially non-deformable dielectric core [provided with], a solderable metal layer completely surrounding said core and a solder layer completely surrounding said solderable metal layer, said bump feature being [and] disposed between said first and second solder pads; and

[a] said solder [region] layer covering at least a portion of each of [(a)] said first solder pad[, (b)] and said second solder pad [and (c) said solderable metal layer].

24. (Amended) A solder-coated article comprising:

a dielectric core having a largest dimension ranging from 1 to 1000 microns;

a solderable metal layer [over] completely surrounding said core; and

a solder layer [over] completely surrounding said metal layer;

wherein said dielectric core has a melting temperature higher than said solder layer.

25. (Amended) A modified substrate comprising:

a substrate;

a metalized pad on said substrate; and

a bump feature on said metalized pad, said bump feature comprising a dielectric core; a solderable metal layer [over] completely surrounding said core; and a solder region [contacting at least a portion of] completely surrounding said solderable metal layer and contacting at least a portion of said metalized pad;

wherein said dielectric core has a melting temperature higher than said solderable metal layer.

26. (Amended) A solder bonded assembly comprising:

a first substrate comprising a first solder pad;

a second substrate comprising a second solder pad;

a bump feature comprising a dielectric core [provided with] a solderable metal layer completely surrounding said core and a solder layer completely surrounding said solderable metal layer, said bump feature being [and] disposed between said first and second solder pads; and

[a] said solder [region] layer covering at least a portion of each of [(a)] said first solder pad[, (b)] and said second solder pad [and (c) said solderable metal layer];

wherein said dielectric core has a melting temperature higher than said solderable metal layer.